Central European Journal of Physics 2014 vol.12 N8, pages 565-577

Application of the generalized Prony spectrum for extraction of information hidden in chaotic trajectories of triple pendulum

Nigmatullin R., Osokin S., Awrejcewicz J., Kudra G.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

In this paper we apply a new method of analysis of random behavior of chaotic systems based on the Prony decomposition. The generalized Prony spectrum (GPS) is used for quantitative description of a wide class of random functions when information about their probability distribution function is absent. The scaling properties of the random functions that keep their invariant properties on some range of scales help to fit the compressed function based on the Prony's decomposition. In paper [1] the first author (RRN) found the physical interpretation of this decomposition that includes the conventional Fourier decomposition as a partial case. It has been proved also that the GPS can be used for detection of quasi-periodic processes that are appeared usually in the repeated or similar measurements. A triple physical pendulum is used as a chaotic system to obtain a chaotic behavior of displacement angles with one, two and three positive Lyapunov's exponents (LEs). The chaotic behavior of these angles can be expressed in the form of amplitude-frequency response (AFR) that is extracted from the corresponding GPS and can serve as a specific "fingerprint" characterizing the random behavior of the triple-pendulum system studied. This new quantitative presentation of random data opens additional possibilities in classification of chaotic responses and random behaviors of different complex systems.

http://dx.doi.org/10.2478/s11534-014-0485-4

Keywords

chaotic behavior, The Prony's decomposition, triple pendulum